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REVIEW

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Post-thyroidectomy voice and swallowing disorders and association with laryngopharyngeal reflux: A scoping review

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Abstract

Objective: Postthyroidectomy voice and swallowing symptoms (PVSS) may occur even in absence of laryngeal nerve injuries, which remains poorly understood. The objective of this review was to investigate the occurrence of PVSS and the potential etiological role of laryngopharyngeal reflux (LPR).

Design: Scoping review.

Methods: Three investigators search PubMed, Cochrane Library, and Scopus databases for studies investigating the relationship between reflux and PVSS. The authors adhered to PRISMA statements and the following outcomes were investigated: age, gender, thyroid features, reflux diagnosis, association outcomes, and treatment outcomes. Based on the study findings and bias analysis, authors proposed recommendations for future studies.

Results: Eleven studies met our inclusion criteria, accounting for 3829 patients (2964 females). Postthyroidectomy swallowing and voice disorders were found in 5.5%–64%; and 16%–42% of patients, respectively. Prospectively, some results suggested an improvement of swallowing/voice disorders postthyroidectomy, whereas others did not observe significant changes. The prevalence of reflux ranged from 16.6% to 25% of subjects who benefited from thyroidectomy. There was an important heterogeneity between studies regarding the profile of included patients, the PVSS outcomes used, the delay of PVSS assessment and reflux diagnosis, making difficult the study comparison. Some recommendations were provided to guide future studies, especially about the reflux diagnosis approach and clinical outcomes.

Conclusion: The potential etiological role of LPR in PVSS is not demonstrated. Future studies are needed to demonstrate an increase of pharyngeal reflux events with objective findings from prethyroidectomy to postthyroidectomy.

Level of Evidence: 3a.

KEYWORDS

head neck, laryngeal, larynx, lobectomy, otolaryngology, surgery, thyroid, thyroidectomy, voice

1 | INTRODUCTION

Thyroid surgery is one of the most common surgical procedures performed worldwide.[1,2] A substantial number of patients reported postthyroidectomy voice and swallowing symptoms (PVSS), for example, globus sensation, dysphagia, sticky mucus, or throat clearing, even in absence of laryngeal nerve injuries.[3,4] The etiology and the pathophysiological mechanisms of PVSS remain unresolved. Many hypotheses were proposed, including endotracheal intubation injury, laryngotracheal fixation, cricothyroid muscle damage or injury of the external branch of the superior laryngeal nerve or lesion of the anastomotic branches between recurrent and superior laryngeal nerves.[5–7] PVSS was also suspected to be related to laryngopharyngeal reflux (LPR) because both conditions report similar clinical picture.[7] Moreover, the thyroid surgery may be associated with upper esophageal sphincter (UES) nerve microtraumas, which may theoretically lead to lower sphincter pressure and tonicity and related esophago–pharyngeal reflux events.[7]

In this scoping review, we investigated the current literature on the occurrence of PVSS and the potential etiological role of LPR.

2 | MATERIALS AND METHODS

The criteria for consideration of inclusion of studies were based on the population, intervention, comparison, outcome, timing, and setting (PICOTS) framework.[8] For each study, three investigators (Jérôme R. Lechien, Stéphane Hans, and Alexandra Rodriguez) independently reviewed and extracted data regarding the PRISMA checklist.[9]

2.1 | Patient population

Prospective or retrospective, controlled, uncontrolled, or randomized clinical studies published in English, Spanish, or French peer-reviewed journals were considered. Studies had to include ≥10 adult patients with history of partial (lobectomy) or total thyroidectomy for whom the occurrence of PVSS and reflux was investigated. The diagnosis of reflux was based on symptoms, findings, or objective examinations, for example, gastrointestinal endoscopy, pH study, or (hypopharyngeal–esophageal) multichannel intraluminal pH-impedance study ([HE]MII-pH). Patients with an LPR diagnosis based on symptoms and findings were considered as suspected LPR, while those with a pH-impedance monitoring diagnosis were considered as LPR patients. Authors investigating the association between PVSS and gastroesophageal reflux disease (GERD) had to report the GERD diagnosis criteria, for example, DeMeester score, Montreal, or Lyon guidelines.[10] There were no exclusion criteria based on age, ethnicity, socioeconomic status, and comorbidities.

2.2 | Intervention

Studies assessing the impact of reflux treatment on PVSS were included in the analysis.

2.3 | Comparison

Studies investigating/comparing the prevalence of reflux in PVSS patient populations versus healthy population were considered.

2.4 | Outcomes

Three investigators (Jérôme R. Lechien, Stéphane Hans, and Alexandra Rodriguez) reviewed the following outcomes: number of patients, age, gender ratio, reflux diagnoses, PVSS investigations and features, outcome association, and potential therapeutic outcomes. The occurrence and types of postthyroidectomy complications were additional outcomes that were investigated by authors.

2.5 | Timing and setting

Populations with PVSS had to be investigated in a delay of 1–12 months postsurgery.

2.6 | Search strategy

The publication search was conducted on PubMED, Scopus, and Cochrane Library databases by three investigators (Jérôme R. Lechien, Stéphane Hans, and Alexandra Rodriguez) the same weekend. The databases were screened for abstracts and titles referring to the description of data of patients with PVSS by the authors. Among the investigators, two authors (Stéphane Hans and Jérôme R. Lechien) analyzed full texts of the selected papers. Findings of the search strategy were reviewed for relevance and the reference lists of publications were examined for additional pertinent studies. Any discrepancies in synthesized data were discussed and resolved by an additional investigator. The following keywords were included and combined: "larynx," "laryngeal," "reflux," "gastroesophageal," "laryngopharyngeal," "thyroid," "swallowing," "voice," "surgery," "thyroidectomy," and "lobectomy". The type of study was classified according to the levels of evidence (I–V).[11] Note that the review was not registered.

2.7 | Bias analysis

The bias/heterogeneity analysis was performed by two independent authors with the Tool to Assess Risk of Bias in Cohort Studies developed by the Clarity Group and Evidence Partners

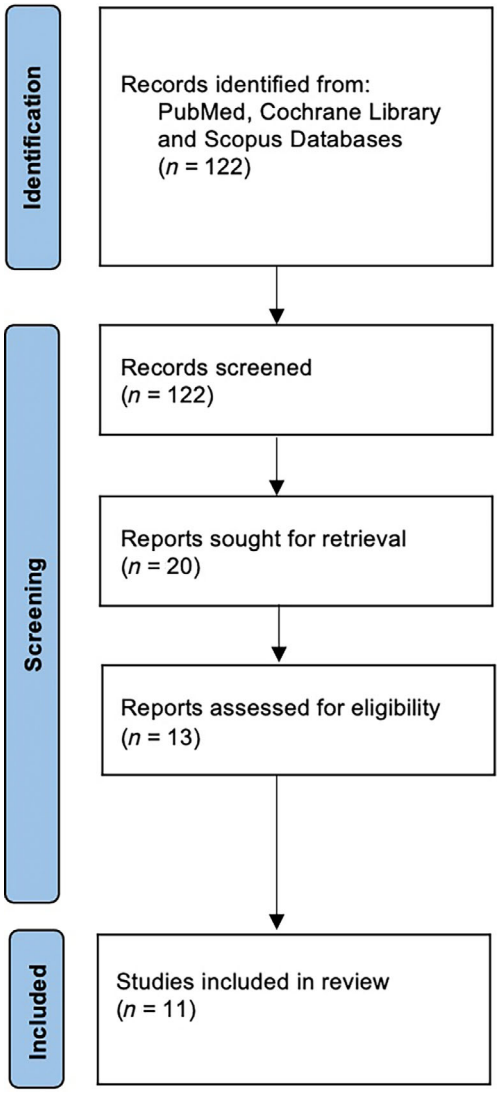

FIGURE 1 Chart flow of the scoping review. PVSS, postthyroidectomy voice and swallowing symptom.

(McMaster University, Canada).[12] The bias analysis consisted of evaluation of cofactors that may impact the association between PVSS and reflux, that is, epidemiological (comorbidities, tobacco use, contributing factors, etc.); complications (laryngeal nerve injuries, etc.); clinical; diagnosis approaches; and therapeutic characteristics of patient groups.

3 | RESULTS

A total of 122 articles were identified and 13 papers met our inclusion criteria (Figure 1).[13–23] Among them, two studies did not investigate the association between PVSS and reflux and were excluded.[4,24] One study focused on stomach physiology throughout the thyroidectomy.[18] The clinical features of studies are available in Table 1. The review included prospective uncontrolled ($N = 8$), prospective controlled ($N = 1$), retrospective case-series ($N = 1$), and cross-sectional ($N = 1$) studies, accounting for 3829 patients. Overlap of patients was detected in two studies.[15,17] There were 2964 females (78.2%) and 824 males (21.8%). The mean age ranged from 41 to 58 years old. Authors included patients who benefited from total thyroidectomy,[13–15,17–21] or both partial and total thyroidectomy.[16,22,23] The indications of thyroidectomy are reported in Table 1. Some authors included only patients with carcinoma (and potential neck dissection),[13] whereas others focused on patients with benign lesions.[15,17,21] The rest of the authors included both benign and malignant lesions.[14,18–20,22,23]

3.1 | Swallowing and voice outcomes

3.1.1 | Postthyroidectomy swallowing disorders

A myriad of swallowing and voice outcomes were used in studies (Table 2). The aim of this review was the investigation of voice or swallowing outcomes of PVSS. The results of the review reported that most studies did not present swallowing screening or assessment or combined voice and swallowing outcomes into one clinical tool (such as reflux symptom index [RSI]). The swallowing and voice outcomes were investigated prethyroidectomy to postthyroidectomy in six studies.[15,17,18,20,21,23] The following postoperative time of study of outcomes was considered in papers: 2 weeks,[23] 1 month,[15,19,20,23] 6 weeks,[23] 3,[13,14,16,20] 6,[21] 12,[23] and 18–24 months.[17]

The swallowing impairment score and the eating assessment tool-10 were both subjective outcomes used in studies.[15,17,20] In the controlled study of Sober et al.,[22] patients who underwent total or partial thyroidectomy reported higher swallowing impairment score than healthy individuals. According to the outcomes used, uncontrolled studies reported a prevalence of abnormal scores of subjective swallowing tools between 5.5% to 64%.[15,19] Among studies comparing prethyroidectomy versus postthyroidectomy times, subjective swallowing symptom questionnaires significantly improved postsurgery in two studies.[17,20] Scerrino et al.[15,17] reported prethyroidectomy to postthyroidectomy significant improvement of UES pressure at the manometry, while there were no significant differences in the lower esophageal sphincter (LES) pressure between both times.

3.1.2 | Postthyroidectomy voice quality disorder

Authors assessed voice quality with the following validated outcomes: voice impairment score, voice handicap index (VHI), grade, roughness, breathiness, asthenia, and strain (GRBAS), and acoustic measurements (Table 2). Kovatch et al.[13] observed in a large cross-sectional survey that 25.8% of patients who underwent total thyroidectomy for a thyroid carcinoma reported 3-month dysphonia, while there were 12.7% with an abnormal VHI-10 scores. Depending on the patient-reported outcome questionnaires or perceptual tools used, the voice quality was considered as subjectively impaired in 16%–42% of cases.[15,19] The occurrence of postthyroidectomy voice quality impairment was not supported by Sober et al.[22] who suggested that subjective (VHI, GRBAS) and objective (acoustic measurements) voice quality

TABLE 1 Study features

Authors	Design	EL	Setting	Outcomes	Results	Findings
Kovatch et al.[13]	Cross-sectional survey	IV	*N* = 2325 TT F/M = 1792/533 Age = 49 yo B/M = 0/2325	3 m post-TT voice changes Abnormal VHI-10 (>11) Association VHI-10-GERD	25.8% 12.7% Significant correlation	12.7% of patients benefiting from TT reported 3 m abnormal VHI-10, which was associated with GERD
Fiorentino et al.[14]	Prospective uncontrolled	IV	*N* = 34 TT F/M = 24/10 Age = 51 yo B/M = 25/9	Post-TT laryngopharyngitis	*N* = 6/24 (25)	LPR symptoms appeared in 25% of patients who completed the evaluations (3 m post-TT)
Scerrino et al.[15]	Prospective uncontrolled	IV	*N* = 36 TT F/M = 26/10 Age = 49 yo B/M = 25/9	30–45 days post-TT impairment Voice impairment score Swallowing impairment score LES pressure and esophageal motility UES pressure and dysmotility	 *N* = 15 (42) *N* = 20 (64) Pre = post-TT Post-TT > pre	UES pressure was impaired post-TT 30–45 days after the surgery, 42% and 64% of patients presented voice and swallowing disorders
Tedla et al.[16]	Prospective uncontrolled	IV	*N* = 39 P/TT Age= >18 yo B/M-F/M = NP	VoiSS score Roughness and strain (GRBAS)	Pre > post Pre > post	VoiSS and Roughness and strain were better pre-P/TT vs. post-P/TT. LPR predicted quality of voice 3 m after surgery
Scerrino et al.[17]	Prospective uncontrolled	IV	*N* = 36 TT F/M = 26/10 Age = 49 yo B/M = 36/0	VIS and SIS UES pressure In patients with post-TT symptoms: LPR symptoms and PE acid events	Pre > 18–24 months post-TT Post-TT > pre Significant correlation	Voice and swallowing symptoms improved post-TT. In symptomatic patients, acid PE events and LPR symptoms were associated.
Xiaoli et al.[18]	Prospective uncontrolled	IV	*N* = 58 TT F/M = 39/19 Age = 41 yo B/M = 39/19	Gastric pH values during TT Gastrin secretion during TT	Pre = during = post Pre = during = post	The secretion of acid and gastrin did not change during the TT surgery
Sahli et al.[19]	Retrospective	IV	*N* = 924 TT F/M = 761/163 Age = 51 yo B/M = 526/398	Voice or swallowing changes (1 m) GERD symptoms Post-TT dysphagia and GERD	148 (16%) - 51 (5.5%) 153 (16.6%) Significant correlation	16% of patients reported voice or swallowing changes post-TT. There was a significant association between GERD and post-TT dysphagia
Marchese et al.[20]	Prospective uncontrolled	IV	*N* = 40 TT F/M = 36/4 Age = 53 yo B/M = 35/5	RFS Voice impairment score, mBMR Swallowing impairment score EAT-10, GERD-Questionnaire Pre-TT vs. post-TT RSI > 13	Pre = 1 m = 3 m post-TT Pre >3 m post-TT Pre >3 m post-TT Pre >3 m post-TT *N* = 8 (20) vs. 1 (2)	Most swallowing and voice symptoms significantly improved post 3-month TT RSI and GERD questionnaire significantly decreased post-TT (3-m)

(Continues)

TABLE 1 (Continued)

Authors	Design	EL	Setting	Outcomes	Results	Findings
Cipolla et al.[21]	Prospective uncontrolled	IV	*N* = 160 TT F/M = 116/44 Age = 47 yo B/M = 160/0	RSI GERD symptoms RSI of pre-TT asymptomatic	Pre > post-TT Pre > post-TT Pre = post-TT	LPR and GERD symptoms significantly decreased post-TT (6-m) in patients with goiter
Sober et al.[22]	Prospective controlled	III	*N* = 118 P/TT CT = 110 CT F/M = 99/19 Age = 58 yo B/M = 97/21	Swallowing impairment score RSI RFS and VHI, GRBAS, Jit, Shim, NHR, and MPT	TT > CT TT > CT TT = CT TT = CT	Patients who benefited from TT had post-P/TT higher score of swallowing impairment score and RSI than healthy controls. Voice quality was comparable between groups
Yoon et al.[23]	Prospective uncontrolled	IV	*N* = 95 P/TT F/M = 73/22 Age = 48 yo B/M = 10/85	RFS RSI	2, 4, 6, and 12 m > pre-TT Pre = 2, 4, 6, and 12 m Post-TT	RFS increased post-P/TT. LPR signs were exacerbated postuncomplicated P/TT. Postsurgery RSI and RFS improved with PPI therapy

Note: The group comparison was presented as "better results" (Gr1 > Gr2: Gr1 results were better than Gr2) or "no significant difference" (Gr = Gr2).

Abbreviations: B/M, benign/malignant thyroid lesion; CT, control; F/M, female/male; GRBAS, grade, roughness, breathiness, asthenia, and strain; F0, fundamental frequency; jit, jitter; LPR, laryngopharyngeal reflux; m, months; mBMRCQ, modified British Medical Research Council Questionnaire; MPT, maximum phonation time; NHR, noise-to-harmonic ratio; NP, not provided; P/TT, partial/total thyroidectomy; PE, proximal esophageal; RFS, reflux finding score; RSI, reflux symptom index; shim, shimmer; TVSQ, Thyroidectomy-related Voice and Symptom Questionnaire; U/lES, upper/lower esophageal sphincter; V/SIS, voice/swallowing impairment symptom; VHI, voice handicap index; yo, years old.

TABLE 2 Swallowing, voice, and reflux outcomes of studies.

Outcomes	N	References
Swallowing outcomes		
Swallowing Impairment Score	3	15,17,20
Eating Assessment Tool-10	1	20
Dysphagia reported by patient (no tool)	1	19
Voice outcomes		
Validated approaches		
Voice Impairment Score	3	15,17,20
Voice handicap index full or − 10	2	13,22
GRBAS	2	16,22
Voice Symptom Score	1	16
Acoustic measurements	1	22
Unvalidated approaches		
Dysphonia reported by patient (no tool)	1	19
Reflux outcomes		
Reflux symptom index	5	16,20–23
Reflux finding score	4	16,20,22,23
UES/LES pressure abnormalities	2	15,17
Laryngopharyngeal signs (unvalidated tool)	1	14
Acid proximal esophageal event	1	15
GERD-Questionnaire (validated)	1	20
Modified British Medical Research Council Questionnaire	1	20
GERD history	1	19

Abbreviations: GERD, gastroesophageal reflux disease; GRBAS, grade, roughness, breathiness, asthenia, and strain; L(U)ES, lower (upper) esophageal sphincter.

parameters appeared to be comparable between patients and controls. Voice quality was evaluated from prethyroidectomy to postthyroidectomy in two studies.[16,20] Tedla et al.[16] reported that voice symptom scale, roughness, and strain significantly improved from prethyroidectomy to postthyroidectomy, while Marchese et al.[20] observed a reduction of voice impairment score at 3 months postsurgery. For both voice and swallowing outcomes, authors of included studies did not provide outcome comparison between partial and total thyroidectomy or between several indications (cancers versus benign lesions).

3.2 | Reflux investigation

The prevalence of reflux in patients with PVSS was investigated in three studies and ranged from 16.6% to 25% of subjects.[14,19,20] In the controlled study of Sober et al.,[22] RSI was significantly higher in postthyroidectomy patients compared with controls, whereas reflux finding score (RFS) did not significantly differ between groups. In total, 31% of postthyroidectomy patients had RSI > 13 compared with 19% in the control group.[22] Authors used various reflux definition and diagnosis approaches (Table 3). No author used hypopharyngeal–esophageal intraluminal impedance pH monitoring (HEMII-pH) to confirm the diagnosis (Table 3). There was a significant association between the occurrence of dysphonia (VHI-10 > 11) and the presence of GERD in the study of Kovatch et al.[13] Similarly, Tedla et al.[16] observed that LPR was a predictor of the voice quality at 3-month postthyroidectomy, whereas Scerrino et al.[17] observed a significant association between acid proximal esophageal reflux events at the esophageal pH-impedance monitoring and the occurrence of LPR symptoms. In the study of Sahli et al.,[19] patients with postthyroidectomy dysphagia had a significantly higher proportion of GERD than others. Depending on the reflux outcomes used, the prethyroidectomy to postthyroidectomy findings reported significant improvements of RSI,[21] GERD questionnaires[20,21] or no significant change.[23] Regarding studies, the RFS did not change postthyroidectomy[20] or worsened.[23] Note that in the study of Yoon et al., postthyroidectomy RSI and RFS improved in patients treated with proton pump inhibitor.[23]

TABLE 3 Reflux definition and diagnosis criteria

Reflux definition	N	References
RSI > 13	3	16,20,22
GERD patient reported history	2	13,19
DeMeester score	2	15,17
Acid proximal esophageal event	2	15,17
Presence of laryngopharyngeal signs	1	14
RFS and RSI (no threshold reported)	1	21
RSI > 12 or RFS >6	1	23

Abbreviations: GERD, gastroesophageal reflux disease; RFS, reflux finding score; RSI, reflux symptom index.

From a basic science standpoint, Xiaoli et al.[18] assessed the gastric secretion of acid and gastrin during total thyroidectomy and did not find significant changes throughout the surgery times.

3.3 | Bias analysis

The scoping review included studies with the following level of evidence: III ($N = 1$), and IV ($N = 10$). According to the bias analysis, there was an important heterogeneity between studies regarding inclusion/exclusion criteria, preoperative/postoperative assessments, reflux diagnosis, and outcomes (Appendix A). Note that we adapted the questions of the bias tool focusing on five data outcomes (exclusion criteria; preoperative–postoperative outcomes; reflux diagnosis and outcomes; and timing of evaluation), which were available in included studies. Among inclusion bias, some authors did not exclude patients with postthyroidectomy laryngeal nerve injury,[13] while this information was not provided in three studies.[14,18,21] The rest of authors excluded patients with laryngeal nerve injuries.[15–17,19,20,22,23] The selection of patients regarding the thyroid features is another inclusion bias. Some teams excluded patients with a high thyroid volume,[15,17] thyroid carcinoma,[15–17] nonpapillary carcinoma,[20] or

thyroiditis,[15,17] which led to heterogeneity in populations across studies. Confounding factors of reflux were poorly considered in most studies (Appendix A). The use of unreliable reflux diagnosis approaches was an important bias in the present review. The HEMII-pH was not used. Only one team used esophageal impedance-pH monitoring in which the reflux diagnosis was not based on proximal reflux events but on DeMeester score (GERD diagnosis criteria).[15,17] The timing of postoperative evaluation of reflux features was judged as adequate in most studies (Appendix A).

4 | DISCUSSION

The occurrence of swallowing and voice disorders after partial or total thyroidectomy was observed since a long time, leading some authors to propose a new condition: the "postthyroidectomy syndrome."[3] Many origins of PVSS have been suspected and may probably occurred in a multifactorial way according to surgery and patient features.[3] LPR is one of the most common PVSS etiologies, which raised popularity over the last decade. The pathophysiology underlying the development of postthyroidectomy reflux is mainly based on the occurrence of cricothyroid muscle damage during the surgery. Indeed, the innervation of UES may involve inferior and superior laryngeal nerves, which may undergo thermal or traction microtraumas during the thyroidectomy; these traumas being imperceptible at the videolaryngostroboscopy examination.[25,26] In the present review, we summarized the current findings about PVSS and the potential influence of reflux. However, many methodological points limit us in the draw of clear conclusion.

First, depending on the underlying thyroid disease (indication), patients may report prethyroidectomy swallowing, voice, or reflux complaints. Rodrigues et al.[27] observed that patients with substernal goiter may present a significant higher rate of LPR symptoms and findings than those without substernal goiter. In the same vein, Nam et al.[28] reported that 35.8% of patients who benefited from thyroidectomy had preoperative abnormal laryngeal conditions, which may be associated with LPR. The findings of these studies support the potential impact of thyroid disease on the preoperative clinical presentation and strengthen the need to investigate the preoperative to postoperative presence of reflux through objective tools, such as HEMII-pH. In addition, the indications of thyroidectomy may substantially impact the postoperative outcomes. The bias analysis reported an important heterogeneity across studies regarding inclusion criteria. For example, in the study of Kovatch et al.,[13] authors only included patients who benefited from thyroidectomy for thyroid carcinoma, some of them having neck dissection. The neck dissection may influence the postoperative outcomes with higher rate of nerve injuries and related UES damages. In the same vein, some authors excluded patients with a high thyroid volume,[15,17] thyroid carcinoma,[15–17] nonpapillary carcinoma,[20] or thyroiditis[15,17] making the cohort incomparable.

Second, recurrent or superior laryngeal nerve injuries are both complications of thyroidectomy associated with voice and swallowing disorders. The inclusion of patients with such lesions in some studies may undoubtedly lead to a postthyroidectomy evaluation bias of symptoms. The lack of investigation of vocal fold movements at the videolaryngostroboscopy to exclude laryngeal nerve injury in other cohorts is another bias evaluation. Another important point that was not investigated in studies was the potential differences in voice and swallowing outcomes between partial and total thyroidectomy. This point is particularly relevant according to the theoretical higher risk of UES nerve lesions in total thyroidectomy versus partial thyroidectomy and the related risk of sphincter tonicity impairment and reflux.

Third, an important point that was considered in most studies is the postthyroidectomy delay for investigating the occurrence of LPR. LPR is considered as a silent reflux, without significant correlation between pharyngeal reflux events and symptoms at the HEMII-pH.[29] In other words, the inflammatory reaction of laryngopharyngeal mucosa required a few weeks of backflow of gastroduodenal content into the upper aerodigestive tract,[30,31] which supports that LPR symptoms develop a few weeks after the surgery. In most studies, authors assessed LPR symptoms and findings at least 6 weeks postthyroidectomy, which seems adequate.

TABLE 4 Recommendations

Preoperative time
To assess the preoperative swallowing and voice symptoms through validated patient-reported outcome questionnaires
To assess the preoperative laryngopharyngeal findings through validated sign instruments
To consider the type and features of thyroid lesion on the preoperative clinical presentation of patients
To evaluate the occurrence of LPR and UES abnormalities through HEMII-pH and high-resolution manometry
Surgical time
To consider surgical steps and features, such as risk of thermal or traction microtraumas, for the postoperative analysis
To consider the type of surgery (partial, total thyroidectomy, and neck dissection) for the final analysis and the indications (cancer versus benign lesions)
Postoperative time
To compare postoperative subjective and objective outcomes with preoperative outcomes according to type of disease and surgeries[a]
To consider same subjective and objective swallowing, voice and reflux tools
To exclude all conditions able to bias the clinical evaluation (confounding factors)
To exclude the laryngeal nerve injuries with adequate clinical tools (i.e., videolaryngostroboscopy)
To evaluate the prevalence of LPR at least at >6-week postthyroidectomy and to consider addition evaluation points
To ensure that patients were comparable regarding thyroid lesion, surgical features, and confounding factors for the group composition

[a]According to literature,[31,35] the postoperative assessment of voice/swallowing may be performed at 1 and 3 months postthyroidectomy.
Abbreviations: HEMII-pH, hypopharyngeal–esophageal intraluminal impedance pH monitoring; LPR, laryngopharyngeal reflux; UES, upper esophageal sphincter.

Fourth, the main weakness of most studies is the lack of consideration of objective findings (e.g., HEMII-pH or high-resolution manometry) to investigate the prevalence of reflux and UES dysfunction before versus after thyroidectomy. To date, the HEMII-pH is commonly accepted as the best diagnostic tool for LPR, identifying acid, weakly acid, or nonacid hypopharyngeal reflux events.[29] The importance of HEMII-pH is strengthened by the nonspecificity of LPR symptoms and findings (e.g., globus sensation, throat clearing, dysphagia, dysphonia), which may be commonly found in patients with laryngeal nerve injury without reflux. Scerrino et al.[15] used esophageal pH-monitoring to investigate esophageal proximal events, but, in practice, we know that many esophageal reflux episodes do not reach pharynx because UES tonicity.[29] From an epidemiological standpoint, the nonspecificity of LPR-symptoms and findings may support the careful exclusion of comorbidities that may be associated with laryngopharyngeal symptoms.[1] According to the bias analysis, it appears that most authors did not exclude some of these prevalent otolaryngological conditions associated with laryngopharyngeal symptoms, for example, chronic rhinosinusitis, allergy, asthma, or inhaled corticosteroid intake.[32–34]

The primary limits of the present review are the low number of studies and the heterogeneity between studies about inclusion criteria, PVSS assessment tools, and reflux diagnosis. There were five studies that investigated swallowing and voice disorders only at postthyroidectomy time. Because LPR is a prevalent disorder, the investigation of a potential association between thyroidectomy and reflux may necessarily involve preoperative to postoperative evaluations. Because the LPR-symptoms and findings may develop over 2–4 weeks,[35] the post-operative assessment may be performed at 1 and 3 months postsurgery.

Another weakness of studies is the few considerations of objective swallowing and voice examinations in patients. Both swallowing and voice quality evaluations have to include subjective, and objective approaches to reach an overall perception of the disorder. Videofluoroscopy, high-resolution manometry, voice quality perceptual evaluations, aerodynamic, and acoustic measurements are all approaches that were poorly considered.

The inability to draw conclusion about the role of reflux in PVSS does not lead to discourage authors to investigate this potential relationship according to the high prevalence of thyroid surgeries in Western countries and the cost and burden of LPR diseases in populations. The development of recent devices dedicated to the diagnosis of reflux (e.g., HEMII-pH, pepsin saliva detection, oropharyngeal pH monitoring) may help authors to conduct future high-quality studies investigating the etiology of PVSS. Thus, we provided recommendations for future studies in Table 4.

5 | CONCLUSIONS

Swallowing and voice changes may occur after thyroid surgery without laryngeal nerve lesion. The etiological role of LPR in PVSS is not yet demonstrated. Future studies are needed to demonstrate an increase of pharyngeal reflux events with objective findings from prethyroidectomy to postthyroidectomy.

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CONFLICT OF INTEREST

The authors have no conflicts of interest.

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APPENDIX A

A.1 | BIAS ANALYSIS

	Exclusion	Preoperative/postoperative	Reflux	Reflux outcome	Timing
References	Criteria	Assessment	Diagnosis	Evaluation	Evaluation
Kovatch et al.[13]	No	No	No	No	Yes
Fiorentino et al.[14]	Probably no	No	No	Probably no	Yes
Scerrino et al.[15]	Probably no	Probably no	Probably yes[a]	Probably yes	Yes
Tedla et al.[16]	Probably no	Probably no	Probably no	N.P.[b]	Yes
Scerrino et al.[17]	Probably no	Probably no	Probably yes[a]	Probably yes	Yes
Xiaoli et al.[18]	Probably no	No	No	No	—
Sahli et al.[19]	No	No	No	No	Probably No
Marchese et al.[20]	Probably yes	Probably yes	Probably no	Probably no	Yes
Cipolla et al.[21]	Probably no	Probably no	Probably no	No	Yes
Sober et al.[22]	Probably no	Probably no	Probably no	Probably no	N.P.
Yoon et al.[23]	Probably yes	Probably yes	Probably no	Probably no	Yes

[a] Considering the acid proximal esophageal event and not the DeMeester score.

[b] No findings available in result section. According to the bias tool used, the following points were considered: Exclusion criteria: yes, exclusion of confounding factors of reflux symptoms/findings (tobacco; alcohol abuse; allergy; previous neck surgery or radiation; laryngeal nerve paresis; laryngeal diseases; chronic rhinosinusitis and reflux preoperative); probably yes, exclusion of some cofactors or only reflux; probably no, no exclusion or reflux and cofactors; no, no information provided. Pre/postoperative assessment: Yes, reflux and voice/laryngeal abnormalities and swallowing disorders were assessed prior thyroidectomy with reliable approaches (stroboscopy, swallowing examination, and hypopharyngeal–esophageal pH-impedance monitoring); Probably yes, reflux or laryngeal/voice abnormalities or swallowing disorders were assessed prior thyroidectomy with poorly reliable tools (subjective evaluation or other approach than hypopharyngeal–esophageal pH-impedance monitoring); Probably no, only laryngeal/voice abnormalities or swallowing disorders or reflux were evaluated; No, no prior laryngeal/reflux/swallowing evaluations. Reflux diagnosis: yes, diagnosis based on pH-impedance monitoring with pharyngeal sensors; probably yes, diagnosis based on pH monitoring or pH-impedance monitoring without pharyngeal sensor; Probably no, diagnosis based on both symptoms and laryngoscopic signs; No, diagnosis based on symptoms or findings or patient history or GERD. Reflux outcome evaluation: yes, pH-impedance monitoring with pharyngeal sensors; probably yes, pH-impedance monitoring without pharyngeal sensor or pH monitoring; Probably no, symptoms and findings; No, symptoms or findings or patient history of GERD. Timing evaluation: yes, assessment of reflux performed >3 months postsurgery; probably yes, assessment performed ≥6 weeks postsurgery; probably no, assessment of reflux performed between 2 and 6 weeks postsurgery; No, assessment performed ≤2 weeks postsurgery.